Claims

1. A single electron tunnelling device comprising a particle together with first and second electrodes positioned adjacent to said particle to facilitate the flow of current therebetween **characterised in that** said particle is formed of a material having a first conductivity characteristic having a surface layer of a material of a second conductivity characteristic, the thickness of said layer being sufficiently small to support quantum mechanical tunnelling therethrough.

2. A single electron tunnelling device according to claim 1 **characterised in that** said device includes a plurality of said particles to define a current path between said first and second electrodes.

3. A single electron tunnelling device according to claim 1 **characterised in that** said material having said first conductivity characteristic is substantially homogenous.

4. A single electron tunnelling device according to any one of claims 1 to 3 **characterised in that** said surface layer is semiconducting.

5. A single electron tunnelling device according to any one of claims 1 to 3 **characterised in that** said surface layer is insulating.

6. A single electron tunnelling device according to claim 1 **characterised in that** said surface layer is gallium arsenide.

7. A single electron tunnelling device according to claim 1 **characterised in that** said surface layer is indium oxide.

8. A single electron tunnelling device according to claim 1 **characterised in that** said surface layer is indium arsenide phosphide.

9. A single electron tunnelling device according to claim 1 **characterised in that** said surface layer is silica.

10. A method of fabricating single electron devices comprising the steps of forming a plurality of particles forming a layer of a thickness sufficiently small to support quantum mechanical tunnelling on the surface of said particles and positioning at least one of said particles between a pair of electrodes to form a single electron device.

11. A method of fabricating single electron devices according to claim 10 **characterised in that** a further step of selecting particles of predetermined size takes place prior to the step of forming said layer.

12. A method of fabricating single electron devices according to claim 10 or 11 **characterised in that** said plurality of particles is formed as an aerosol.

13. A method of fabricating single electron devices according to claim 10 or 11 **characterised in that** said layer is formed by the chemical modification of the surface of said particles.

14. A method of fabricating single electron devices according to claim 10 or 11 **characterised in that** said layer is formed by the expitaxial deposition of a material on the surface of said particles.

15. A method of fabricating single electron devices according to claim 10 **characterised in that** the positioning of said particle is performed by means of an atomic force microscope.

16. A method of fabricating a single electron device comprising the steps:

forming a plurality of particles;

forming on the surface of each particle a peripheral layer of a thickness sufficiently small to support quantum mechanical tunnelling therethrough;

providing a pair of electrodes and positioning at least one of said particles between said pair of electrodes to form a single electron device.

17. A method of fabricating a single electron device according to Claim 16, wherein a further step of selecting particles of predetermined size takes place prior to the step of forming said peripheral layer.

18. A method of fabricating a single electron device according to Claim 16, wherein said plurality of particles is formed as an aerosol.

19. A method of fabricating a single electron device according to Claim 16, wherein said peripheral layer is formed

by chemical modification of the surface of each of said particles.

20. A method of fabricating a single electron device according to Claim 16, wherein said peripheral layer is formed by the epitaxial deposition of a material on the surface of each of said particles.

21. A method of fabricating a single electron device according to Claim 16, wherein the positioning of said particle is performed by means of an atomic force microscope.

22. A method of forming a single electron tunnelling device comprising:

forming a particle of a material having a first conductivity characteristic, forming on the particle a semiconducting surface layer of a second conductivity characteristic, the thickness of said layer being sufficiently small to support quantum mechanical tunnelling therethrough; and

positioning said particle between first and second electrodes to provide a current path between the electrodes.

23. A method of forming a single electron tunnelling device, comprising:

forming a particle of a material having a first conductivity characteristic;

forming on the surface of the particle a surface layer of gallium arsenide, the thickness of said layer being sufficiently small to support quantum mechanical tunnelling therethrough; and

positioning said particle between first and second electrodes to provide a current path therebetween.

24. A method of forming a single electron tunnelling device, comprising:

forming a particle of a material having a first conductivity characteristic;

forming on the surface of the particle a peripheral layer of indium oxide, the thickness of said layer being sufficiently small to support quantum mechanical tunnelling therethrough;

positioning said particle between first and second electrodes to provide a current path therebetween.

25. A method of forming a single electron tunnelling device, comprising:

forming a particle of a material having a first conductivity characteristic;

forming on the surface of the particle a peripheral layer of indium arsenide phosphide, the thickness of said layer being sufficiently small to support quantum mechanical tunnelling therethrough;

positioning said particle between first and second electrodes to provide a current path therebetween.

26. A method of forming a single electron tunnelling device, comprising:

forming a particle of a material having a first conductivity characteristic;

forming on the surface of the particle a peripheral layer of silica, the thickness of said layer being sufficiently small to support quantum mechanical tunnelling therethrough;

positioning said particle between first and second electrodes to provide a current path therebetween.

27. A method forming an electronic device, comprising:

forming at least one nanoparticle having an inner core of a conductive material of predetermined size of nanometer dimensions;

forming on the inner core, an outer shell of a controlled thickness of nanometer dimensions and of a further material which is different from that of the inner core; and

providing first and second electrodes, and providing a current flow path therebetween comprising said at least one particle, the characteristics of current flow in the current flow path being determined by electron tunnelling via said outer shell and inner core.

28. A method according to Claim 27, wherein said further material is insulating.

29. A method according to Claim 28, wherein said further material is an oxide of one of: silicon, indium, aluminium.

30. A method according to Claim 27, wherein said further material is semiconducting.

31. A method according to Claim 30, wherein said semiconducting material contains one of the following:

indium, silicon.

32. A method according to Claim 27, wherein said conductive material contains one of:

silicon, germanium, indium, gallium.

33. A method according to Claim 27, comprising providing a multiplicity of said nanoparticles stacked adjacent one another whereby to provide said current flow path.

34. A method of forming a nanocrystal in the form of a particle that is defined by a size of nanometer dimensions, the method comprising:

forming, in an aerosol, a core particle of an electrically conductive material and having a size of predetermined nanometer dimensions; and

forming epitaxially on the core particle, by the action of gas on the aerosol, an outer shell of a further material that is different from that of the core, and having a controlled thickness of nanometer dimensions.

35. A method according to Claim 34 wherein said conductive material contains one of:

silicon, germanium, indium, gallium.

36. A method according to Claim 34, wherein said further material is semiconducting.

37. A method according to Claim 34, wherein said conductive material contains one of the following:

indium, germanium, gallium;

and said further material is semiconducting and comprises one of the following:

indium, silicon, aluminium.

38. A method of forming a nanocrystal in the form of a particle that is defined by a size of nanometer dimensions, the method comprising:

forming in an aerosol, a core particle of an electrically conductive material and having a size of predetermined nanometer dimensions; and

exposing the gas to an aerosol, the gas reacting with the surface of the core particle to form an outer shell of a further material that is different from the material of the core particle, and that has a controlled thickness of nanometer dimensions.

39. A method according to Claim 38, wherein the gas reacts with the surface of the core particle to form an oxide of the core material.

40. A method according to claim 39, wherein the core particle contains one of: silicon, indium.

41. A method according to Claim 38, wherein the gas reacts with the surface of the core particle by an exchange process, wherein atoms in the surface of the core particle are exchanged for atoms in the gas.

42. A method according to Claim 41, wherein the core material is a compound semiconductor, and the gas comprises molecules containing phosphorus.

43. A method according to claim 42, wherein the core material comprises indium arsenide, and arsenic atoms are replaced by phosphorus atoms.

44. A method of forming a nanocrystal in the form of a particle that is defined by a size of nanometer dimensions, the method comprising:

forming from an aerosol, a core particle of an electrically conductive material and having a size of predetermined nanometer dimensions; and

forming epitaxially on the core, by the action of gas on the aerosol, an outer shell of a further material that is different from that of the core, and having a controlled thickness of nanometer dimensions; and

reacting the outer shell to form an oxide of the further material.

45. A method according to Claim 44, wherein the conductive material is gallium arsenide, the further material is aluminium arsenide, and said oxide is aluminium oxide.

46. A method of forming nanocrystals comprising:

a) forming an aerosol of particles of a predetermined conductive material and diameters of nanometer dimensions;

b) filtering said aerosol of particles to provide particles with a narrow predetermined spread of diameters; and

c) processing the filtered aerosol with a vapour of a material in order to form a shell of a further material on each aerosol particle and of a controlled thickness, said further material being different from said predetermined conductive material.

47. A method according to Claim 46, wherein said processing in step c) comprises forming by an epitaxial process said shell.

48. A method according to Claim 47, wherein said conductive material contains one of:

indium, germanium, gallium;

and said further material includes one of:

indium,silicon, aluminium.

49. A method according to Claim 46, including the further step of reacting the further material of the outer shell to form an oxide.

50. A method according to Claim 49, wherein said inner core comprises gallium arsenide, said further material comprises aluminium arsenide, and said oxide comprises aluminium oxide.

51. A method according to Claim 46, wherein in said step c) said vapour reacts with the surface of the particle in order to form said shell by modification of the surface of the particle.

52. A method according to Claim 51, wherein the modification is an exchange process.

53. A method according to claim 51, wherein the particle material is a compound semiconductor, and the vapour comprises molecules containing phosphorus.

54. A method according to claim 53, wherein the particle material comprises indium arsenide, and arsenic atoms are replaced by phosphorus atoms so that the material of the shell is indium arsenide phosphide.

55. A method according to Claim 51, wherein the modification is formation of an oxide.

56. A method according to Claim 55, wherein the material of the particle is one of: silicon, indium.

57. A method according to claim 46, wherein said step a) comprises:

forming an aerosol of group III metallic particles, and filtering the aerosol to provide particles with a narrow predetermined dimensional spread; and

reacting the aerosol with a group V precursor gas, in order to provide an aerosol of particles consiting og III-V semiconductor material.